THREE MONTH CLINICAL PROSPECTIVE INTERVENTION STUDY USING FOUR KEYBOARDS

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INTRODUCTION

In response to the recent increase in work-related musculoskeletal disorders (WRMSDs), many alternatively designed keyboards have been developed and marketed with the goals of increasing user's comfort and reducing the risk factors of awkward postures. Recent short-term laboratory studies have shown that several of these keyboards can achieve the objectives of altering wrist and forearm postures (Burastero 94, Rempel 94) and reducing muscle activities (Gerard, 94). Yet, there is no evidence to demonstrate that alternative keyboards are effective in preventing or managing WRMSDs with long term use. The purpose of this study was to determine the long term effects of 4 keyboards on patients with musculoskeletal disorders.

METHODS

Sixty employees with hand and wrist pain at the Lawrence Livermore National Laboratory (LLNL) who used a keyboard for ≥20 hours per week participated in a randomized observer-blinded clinical trial. Diagnoses were made by two trained nurse practitioners using a standardized physical examination.

Subjects were matched by diagnoses, the degree of symptom severity and average hours of keyboard use per week. Matched subjects were randomized into four keyboard groups while standard clinical treatment was provided regardless of group assignment. Throughout the trial period, subjects were asked to use the assigned keyboards at configurations defined to be most neutral by a researcher. The four keyboards evaluated were the Apple Adjustable, Comfort HealthCare, Microsoft Natural and Standard Apple Extended Keyboards.

Questionnaires containing a series of 10-point visual analogue scales (VAS) were administered on the day the keyboards were distributed, 6 weeks and 12 weeks after the keyboards were used. Subjects were asked to 1) rate their overall discomfort and pain level 2) identify and rate symptomatic areas using the hand, wrist and forearm diagram and 3) rate the level of difficulty when performing essential activities of daily living (e.g., turning a door knob, writing, opening jars, driving, picking up small objects, etc.) (Pransky, 92).

In addition, subjects completed a Work Interpersonal Relationship Inventory (WIRI) questionnaire which included subscales on supervisor support and conflict and co-worker support and conflict. Several investigators have suggested that musculoskeletal symptoms can increase with work stress or poor interpersonal factors (Bernard 93, Faucett 94) .

RESULTS

The effect of four keyboards on overall pain and discomfort level are presented in Table 1. were reported by the Apple Extended Keyboard group.

	Wk #0	Wk#6	Wk#12
Apple Adj.	$2.8^{\pm}$ 2.4^{a}	$2.7^{\pm}$ 1.9^{a}	$2.3^{\pm}$ 1.8^{a}
Comfort	$2.7^{\pm}1.5^{a}$	$2.1^{\pm}$ 1.3^{b}	$2.4^{\pm}2.0^{a,b}$
Micro-soft	$3.3^{\pm}2.1^{a}$	$2.6^{\pm}$ 1.9^{b}	$1.7^{\pm}$ 1.4^{c}
Apple Flat	$2.3^{\pm}$ 1.6^{a}	$2.3^{\pm}$ 1.8^{a}	$2.6^{\pm}$ 2.0^{a}

Table 1. Overall mean pain level (0=no pain, 10=worst pain imaginable) over time for 4 keyboard groups . Mean values containing a different superscript within a row are significantly different ($p<0.05$). No significant interaction between keyboard and time was observed.

Over 3 months, pain and discomfort experienced by both the Apple Adjustable and Comfort Health Care Keyboard groups decreased, though not significantly from 2.8 to 2.3 and 2.7 to 2.4. respectively. Pain and discomfort among the Microsoft Natural Keyboard users significantly decreased from 3.3 to 1.7. Users of the standard Apple Extended Keyboard, however, reported a slight, but not significant increase in overall pain and discomfort level over time.

The effects of four keyboards on volar and dorsal hand and wrist pain over time are summarized in Tables 2 and 3. Pain in the volar aspect of the hand significantly decreased over 6 or 12 weeks for all keyboard groups. Pain in the dorsal aspect of the hand and wrist increased for the groups that used the Apple Adjustable and Comfort HealthCare Keyboards, though not significantly from 0.61 to 1.0 and 1.6 to 2.0 respectively. Wrist and hand pain level reported among the Microsoft Natural Keyboard users significantly decreased from 2.5 to 0.71 whereas users of the Apple Extended keyboard reported relatively constant pain level over time.

	Wk #0	Wk#6	Wk#12
Apple Adj.	$1.8^{\pm}$ 1.3^{a}	$0.2^{\pm}$ 1.2^{b}	$0.4^{\pm}1.1^{b}$
Comfort	$1.1^{\pm}1.7^{a}$	$2.1^{\pm}$ 3.1^{b}	$0.6^{\pm}1.4^{c}$
Micro-soft	$2.9^{\pm}2.0^{a}$	$0.6^{\pm}$ 1.4^{b}	$0.7^{\pm}$ 1.4^{c}
Apple Flat	$1.4^{\pm}$ 1.8^{a}	$0.6^{\pm}$ 1.7^{b}	$0.6^{\pm}$ 1.5^{b}

Table 2. Mean volar hand and wrist pain (0=no pain, 10=worst pain imaginable) over time for 4 keyboard groups . Mean values containing a different superscript within a row are significantly different ($p<0.05$). No significant interaction between keyboard and time was observed.

	Wk #0	Wk#6	Wk#12
Apple Adj.	$0.61^{\pm}$ 1.3^{a}	$0.0^{\pm}$ 0.0^{b}	$1.0^{\pm}$ $2.5^{a,b}$
Comfort	$1.6^{\pm}1.7^{a}$	$0.38^{\pm}0.74^{b}$	$2.0^{\pm}2.4^{a,b}$
Micro-soft	$2.5^{\pm}2.6^{a}$	$0.61^{\pm}$ 1.5^{b}	$0.71^{\pm}$ 1.2^{b}
Apple Flat	$0.74^{\pm}$ 1.5^{a}	$0.14^{\pm}$ 0.54^{a}	$0.72^{\pm}$ 1.5^{a}

Table 3. Mean dorsal hand and wrist pain (0=no pain, 10=worst pain imaginable) over time for 4 keyboard groups .

Functional status ratings based on a VAS is summarized in Table 4. Results suggest that over time, most hand functional activity difficulties such as turning a door knob, putting on shoes/socks and sleeping improved for all alternative keyboard groups and did not change or worsened for the Apple Extended Keyboard group. For example, mean difficulty level when putting on shoes/socks significantly decreased from 2.0 to 0.62 for the Microsoft Natural Keyboard users compared to an increase from 0.77 to

1.31 for the Apple Extended users ($p<0.05$).

The effects of work-related interpersonal factors on symptom severity were also investigated. Preliminary findings suggest that for those who scored below the median on the WIRI supervisor conflict subscale (Low Supervisor Conflict), a significant reduction in pain severity over time was demonstrated. The group who scored above the median (High Conflict group), on the other hand, exhibited no significant change in pain severity over time. Table 5 presents summary of these results.

	Wk #0	Wk#6	Wk#12
High Supervisor Conflict	1.2 ± 1.8^{a}	$1.8 \pm 1.5^{*a}$	1.2 ± 2.1^{a}
Low Supervisor Conflict	1.3 ± 1.6^{a}	$0.6 \pm 1.7^{*b}$	0.3 ± 0.9^{b}

Table 5. The effect of 4 keyboards on mean wrist and hand pain over time for low and high supervisor conflict groups. * indicates significant interaction between conflict groups and time on volar hand and wrist pain ($p<0.05$). Dissimilar superscripts within a row denote significant post-hoc pairwise comparisons. ($p<0.05$).

CONCLUSIONS

These results suggest that over three months, overall pain and discomfort as well as functional status among employees with hand and wrist pain improved when using the Apple Adjustable, Comfort HealthCare and Microsoft Natural Keyboards. Such clinical improvement was statistically significant for the Microsoft Natural Keyboard group. Work-related functional activity such as keyboard use, improved significantly for all alternative keyboard groups but, remained relatively constant for the Apple Extended Keyboard group.

In terms of site-specific pain over time, the Microsoft Natural Keyboard users experienced significant reduction in pain in both the volar and dorsal aspects of the hands. The Apple Adjustable and Comfort HealthCare Keyboard groups reported a significant decrease in mean volar hand pain, but a nonsignificant increase in the mean dorsal hand pain. Users of the Apple Extended keyboard reported a significant decrease in the mean volar pain, and experienced a relatively constant dorsal hand pain.

Preliminary analysis of work-related psychosocial factors suggests that interpersonal relationships such as employee-supervisor conflict can significantly affect pain severity over time. These factors may potentially modify the effect of keyboard use on hand and wrist pain. Further investigation is needed to determine if interaction between psychosocial factors and keyboard use exists.

Finally, significant improvement in symptoms and hand functional status among the Microsoft Natural Keyboard group may be attributed to the alleviation of awkward wrist postures toward neutral (Rempel, 95). Biomechanical analysis of the hand and wrist during use of alternative keyboards are underway to determine if there is an association between wrist postures and clinical progress.

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	Apple Adj	Comfort	Microsoft	Apple Ext.
Turning door knob*				
Time				
Week 0	1.9±2.1[a]	1.8±1.7[a,b,c]	2.3±2.2[b]	1.4±1.8[a,c]
Week 12	1.4±1.8	0.9±1.8	0.9±1.1	1.7±1.9
Picking up small obj				
Time				
Week 0	1.4±1.8	1.0±1.8	1.1±1.9	1.4±2.0
Week 12	1.1±1.5	0.5±0.9	0.5±0.8	1.4±1.9
Putting on shoes*				
Time				
Week 0	1.4±1.9[a]	0.4±0.6[b]	2.0±2.5[b,c]	0.8±1.4[d]
Week 12	1.3±2.1	0.0±0.0	0.6±0.8	1.3±0.8
Driving > 30 min*				
Time				
Week 0	2.9±2.3	1.0±1.3	3.4±3.1	1.9±2.4
Week 12	2.7±2.7	1.2±1.8	1.5±1.7	2.3±2.7
Sleeping				
Time				
Week 0	3.1±3.3	0.9±0.9	2.1±1.7	2.0±2.5
Week 12	1.8±2.1	0.3±0.6	1.1±0.9	2.5±2.4
Performing job				
Time				
Week 0	2.6±2.4	2.0±1.8	3.6±2.6	2.5±1.7
Week 12	1.8±1.9	2.3±1.7	1.2±1.2	2.2±2.3
Using keyboard*				
Time				
Week 0	2.6±2.2[a]	2.7±2.1[a,c,d]	3.6±2.5[b]	2.5±1.7[a,d]
Week 12	1.9±2.3	2.5±1.8	1.0±1.2	2.5±2.5

Table 4. Mean function ratings over time for 4 keyboards. * indicates significant interaction between keyboard and time on functional activity ($p<0.05$). Unlike superscripts indicate significant pairwise comparisons (post-hoc contrasts) ($p<0.05$).